



Visualization for Decision Superiority



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Purpose

Explain how different visualization techniques can aid decision makers in shortening the decision cycle, decreasing information uncertainty, and improving situational awareness.

Based on 2 Papers

- ▶ Increasing Situational Awareness by Combining Realistic and Non-Realistic Rendering Techniques
 - ▶ Valerie A. Summers¹, Aline Normoyle¹, Robert Flo²
- ▶ Increasing Situational Awareness by Visualizing Uncertainty
 - ▶ Valerie A. Summers¹, Richard L. Jones¹, Robert Flo²

MÄK Technologies¹

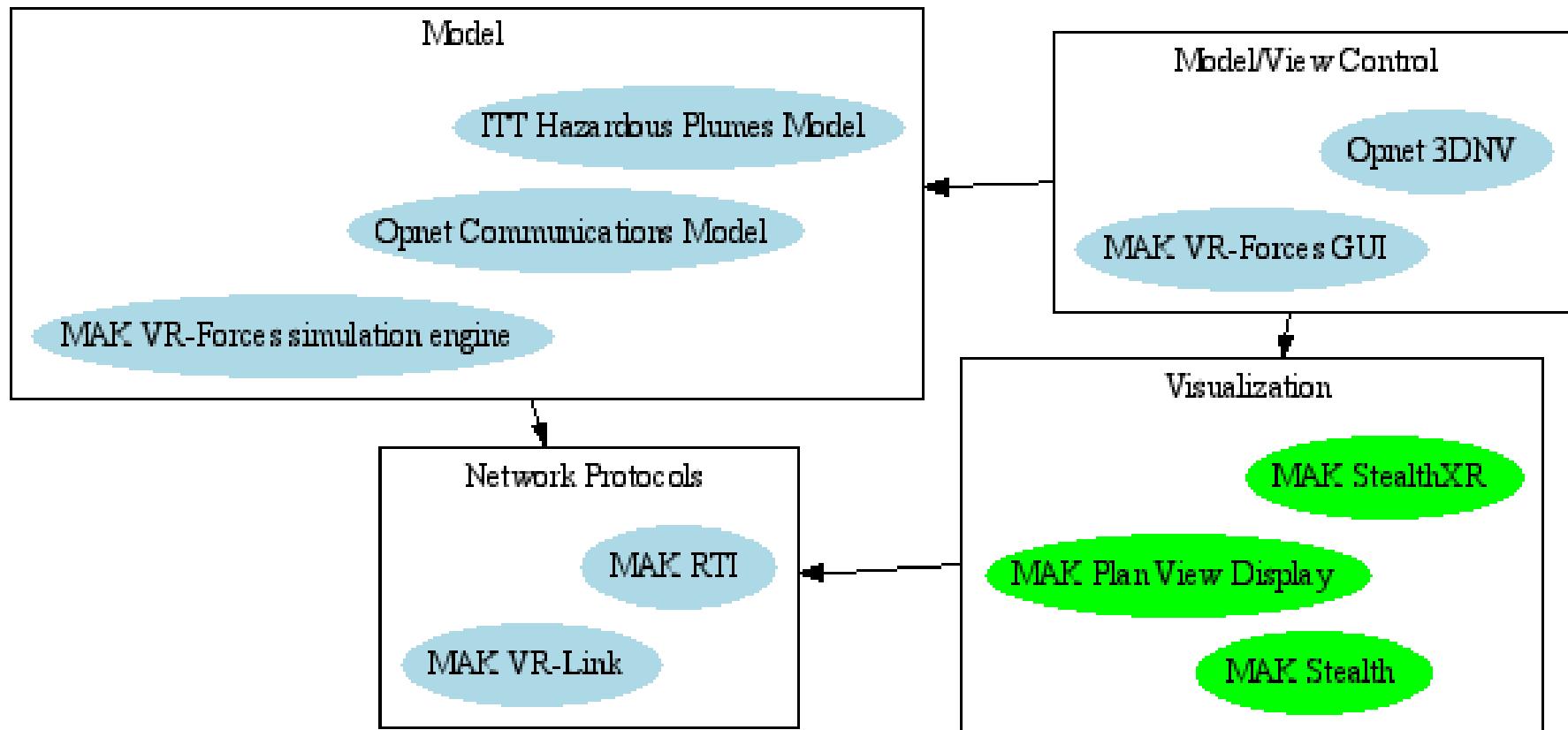
U.S. Air Force, Rome Labs²

Visualization of Information is not...

- ▶ Fusing information
- ▶ Improving information estimates
- ▶ Collating multiple information sources

Visualization is displaying information
graphically on a display

Where Visualization Fits



Availability

- ▶ Products commercially available
- ▶ Available through the U.S. Air Force for other programs
- ▶ Works out of the box with HLA, DIS
- ▶ Use plug-in API to work with Link16
- ▶ C2PC injector stimulated via HLA
- ▶ Various platforms including MS Windows and Linux

Requirements Source

- ▶ Human computer interaction research
- ▶ Military subject matter experts
- ▶ Toolkit Customers (both foreign and domestic)
- ▶ Feedback from fielded simulation applications

Visualization Goals

- ▶ Reduce information process time for decision makers
- ▶ Enable information manipulation
 - ▶ Filter
 - ▶ Clarify
 - ▶ Value
- ▶ Improve situational awareness of the known, unknown, and the uncertain

Knowledge Organization

Knowledge voids	Collection plan emphasis	Altitude, timeliness
Coverage + no threats	Supply / evacuation routes	Visualization of uncertainty
Coverage + threats	Time Sensitive Targeting	Clutter (too much data) Confidence values

Software Development Goals

- ▶ Enable display customization
- ▶ Enable de-cluttering the display
- ▶ Integrate
- ▶ Cross-tool control
- ▶ Toolkit
- ▶ Visualization techniques work together

Approach: 3 non-realistic techniques

- ▶ **Visualization of non-visual data**
- ▶ Alternative visualization
- ▶ Data reduction

Criteria for Visualization of Non-visual Data

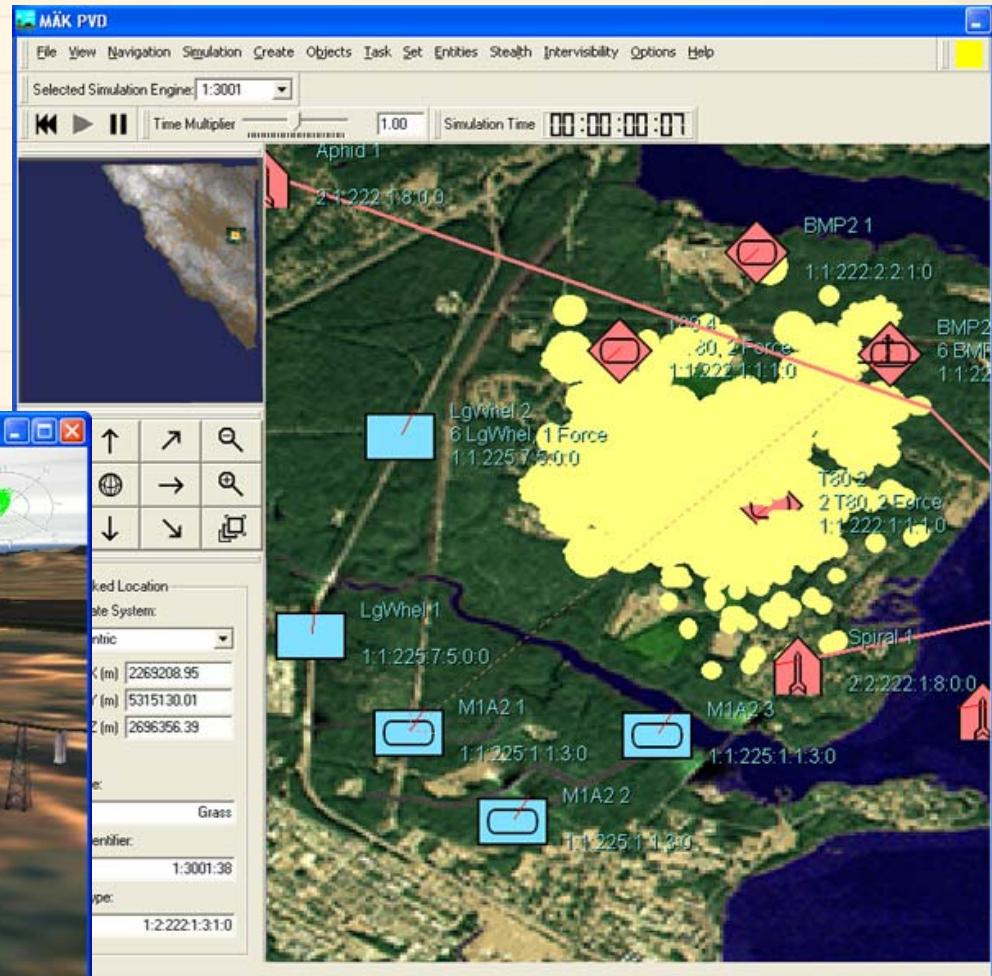
- ▶ Relevant to user
- ▶ Help user with his/her task
- ▶ Have a spatial representation

Dynamic Spatial Data – Changes rapidly over time

- ▶ Biological, chemical or nuclear plumes
- ▶ Communication lines
- ▶ Threat ranges
- ▶ Sensor coverage
- ▶ Drop down lines with altitude labels (precise XY location not obvious in perspective views)
- ▶ Trajectory histories (help predict future locations and AARs)
- ▶ Inter-visibility lines

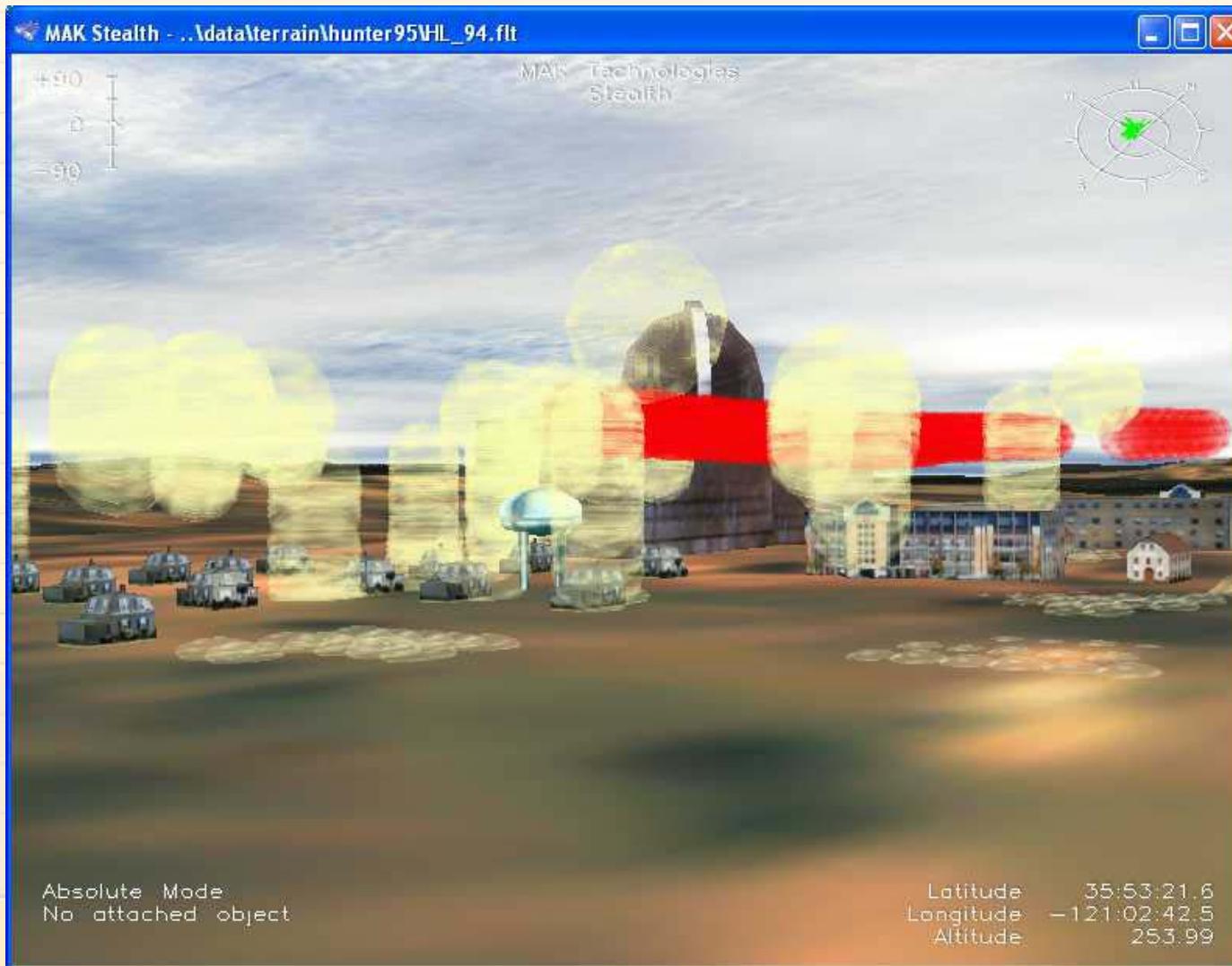
Weapons of Mass Destruction

Nuclear, Biological or Chemical



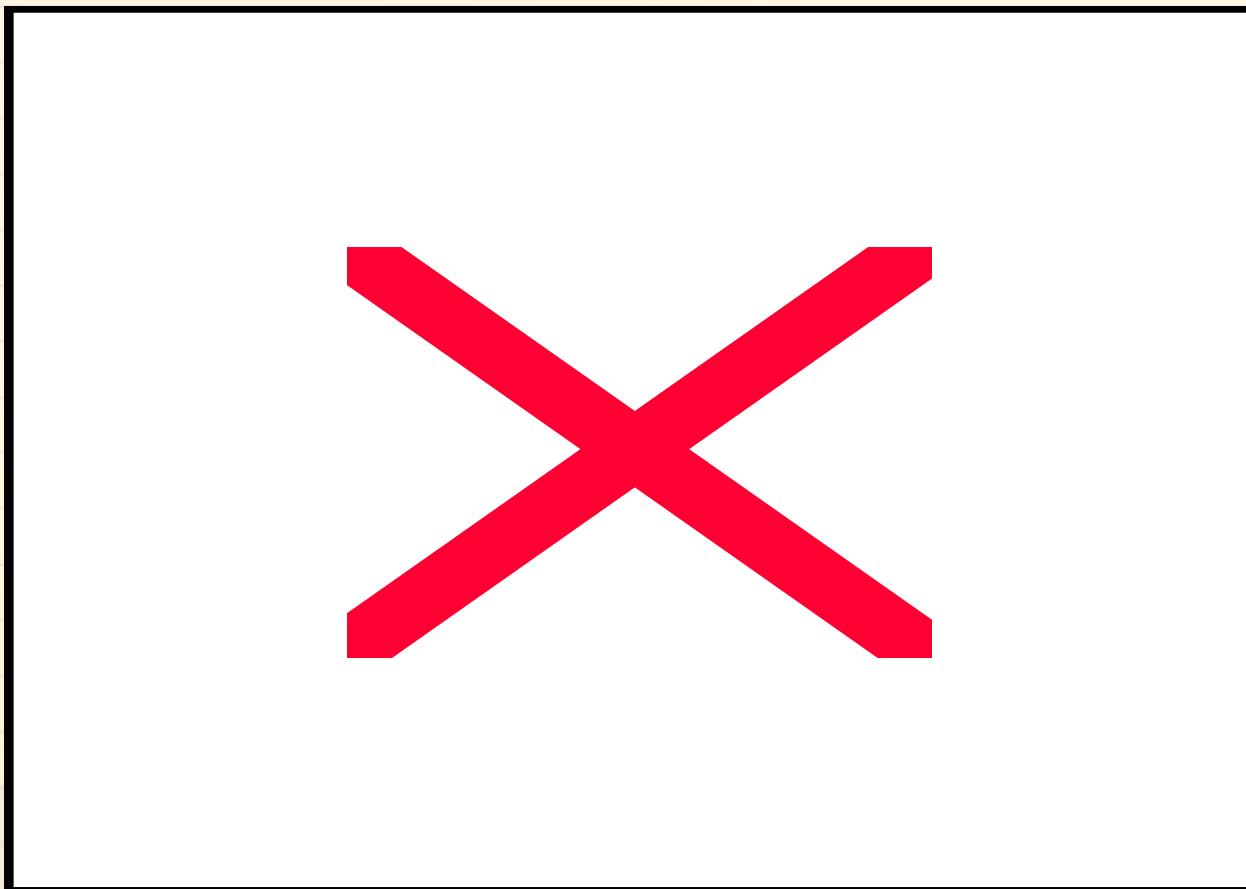
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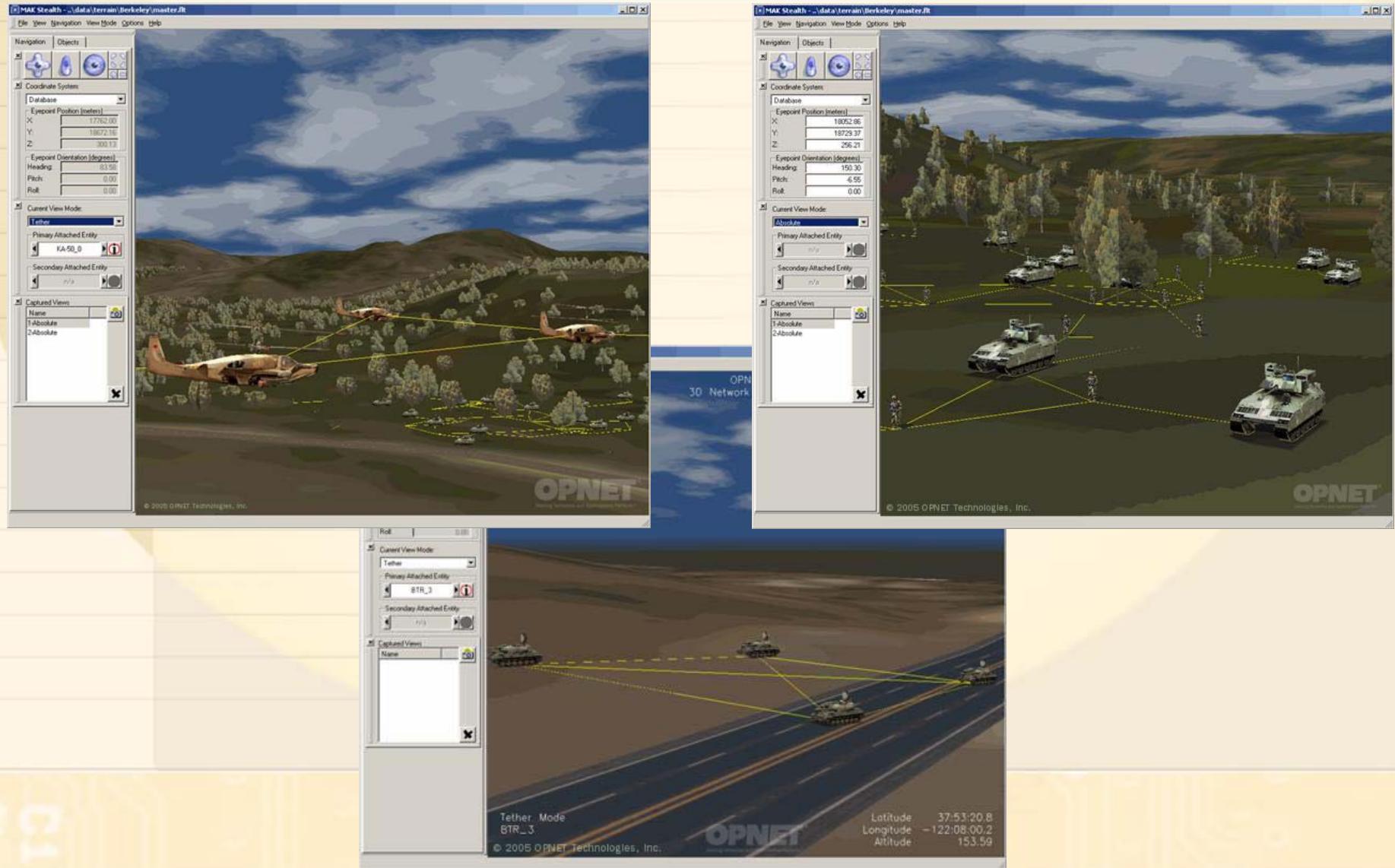


Weapons of Mass Destruction

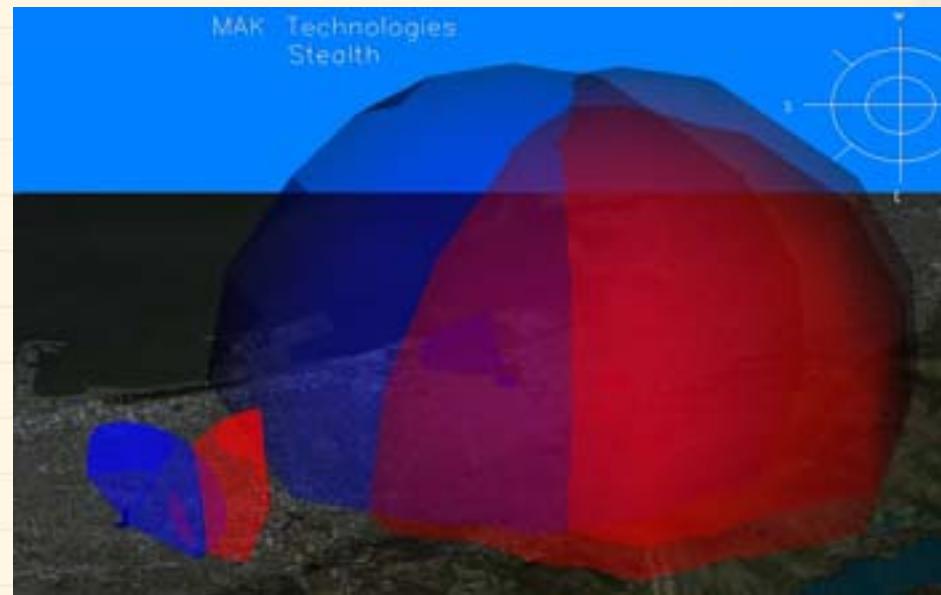
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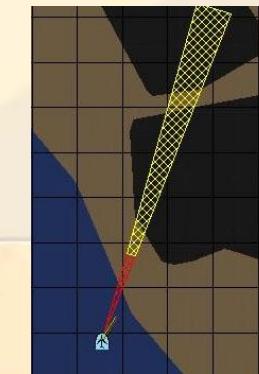
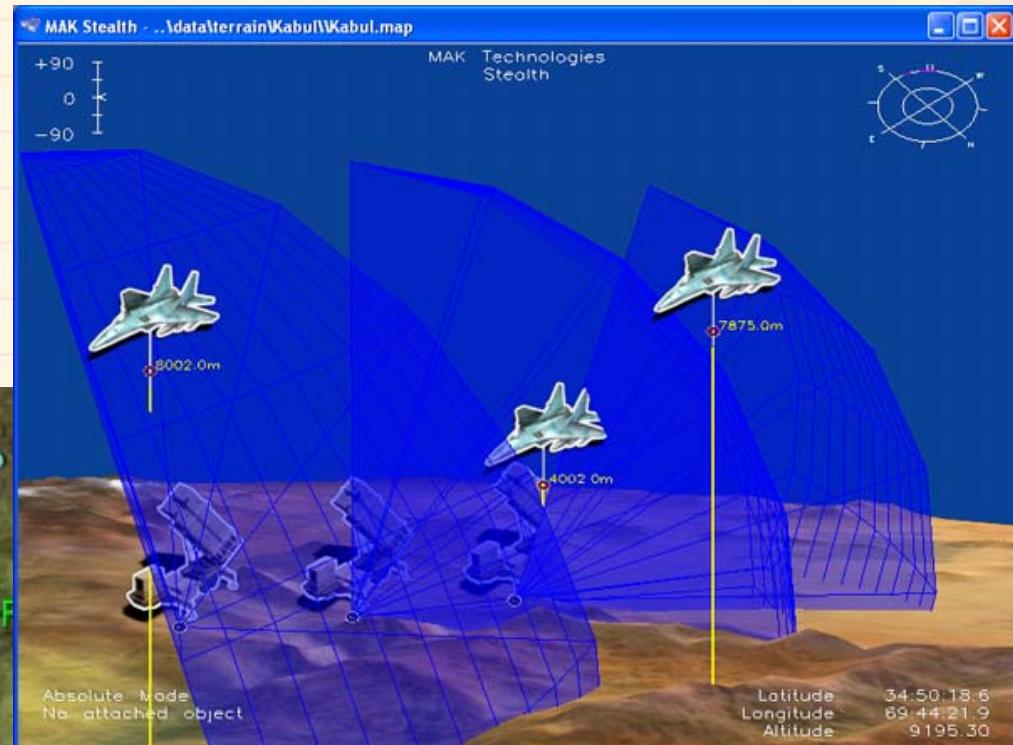
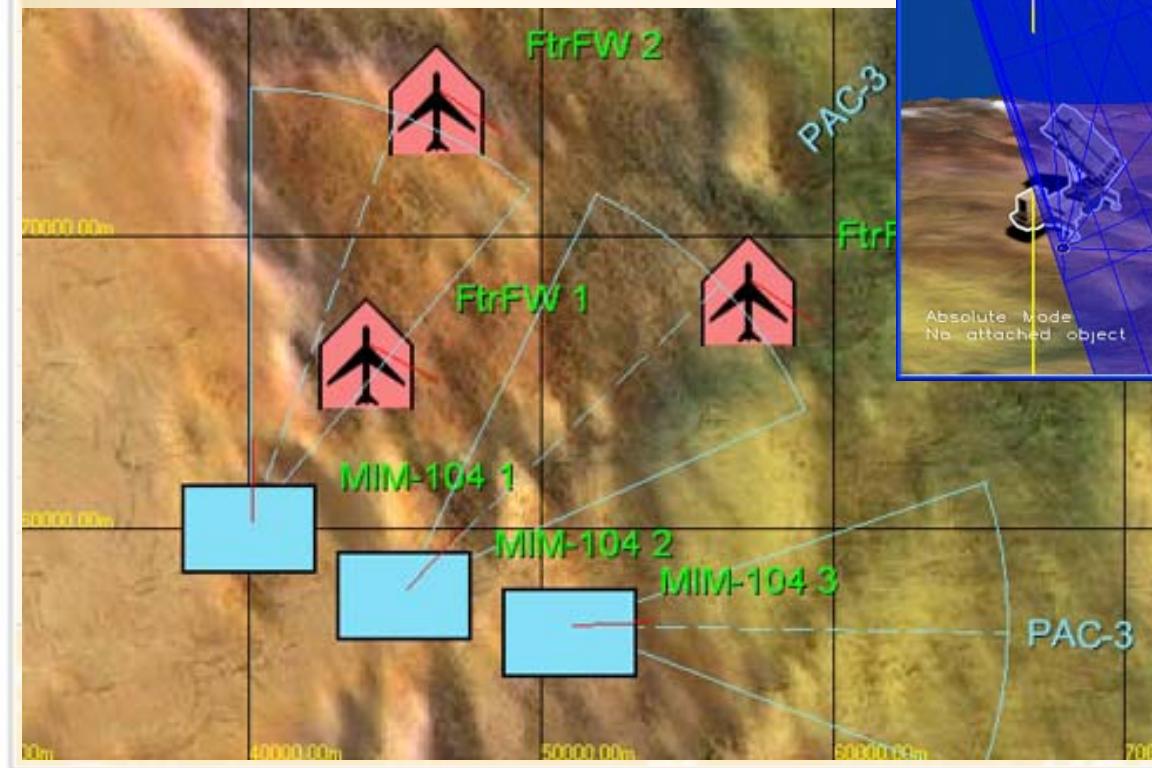
Communications



Weapon System Threat Envelopes



Sensor Coverage



Static Spatial Data

- ▶ Tactical graphics
 - ▶ Planned routes
 - ▶ Waypoints
 - ▶ Areas of impassible terrain
 - ▶ Phase lines
 - ▶ Engineering objects
 - ▶ ...

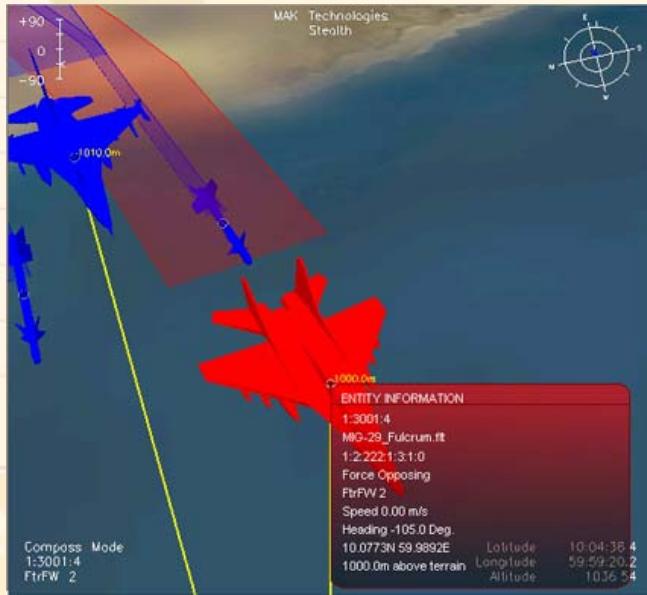
Tactical Graphics



Approach: 3 non-realistic techniques

- ▶ Visualization of non-visual data
- ▶ **Alternative visualization**
- ▶ Data reduction

Unit Representation



The screenshot shows the VR-Forces 1 software interface. The top menu bar includes File, View, Navigation, Simulation, Create, Objects, Task Set, Entities, Stealth, Intervisibility, Options, and Help. Below the menu is a toolbar with buttons for Select Objects, navigation (Back, Forward, Stop), Time Multiplier (set to 1.00), and Simulation Time (00:00:00:23). A left panel contains a terrain map of Maryland with a yellow box highlighting the Julian's Jetty area, and a coordinate input field for Geocentric coordinates (X: 3139415.55, Y: 5441228.52, Z: 1102589.05) and an intersects counter (1:3001:1).

The main map view displays Julian's Jetty, Maryland, with several labeled entities:

- Sidewd 2
- Sidewd 3
- FtrFW 1
- Sidewd 4
- FtrFW 2

These entities are represented by blue and red icons. A legend indicates "Missile missile" and "Unmanned missile" types. The map also features contour lines, roads, and labels like "LAND", "Stazione", "Julian's Jetty", "Granary", "Estate Park", "Morristown Blvd.", "Main St.", "Mine Av.", "Quartz", "Old", "CAMP", and "C.D. Avenue". A scale bar at the bottom right shows distances from 0 to 100 meters.

Deciding Which to Use

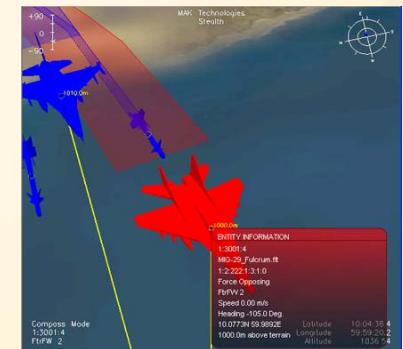
► Realistic

- ▶ + Unit details
- ▶ + Emotional factors
- ▶ - Screen clutter (no scaling or aggregation)
- ▶ - Worst performance



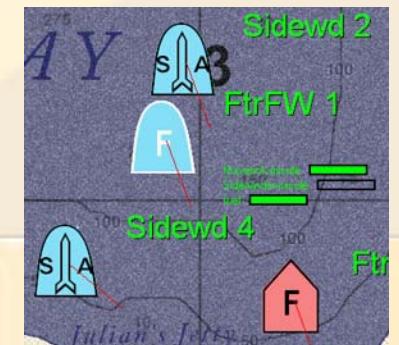
► Non-realistic (Impressionistic)

- ▶ + Partial unit detail (force id and orientation)
- ▶ Faster performance than realistic

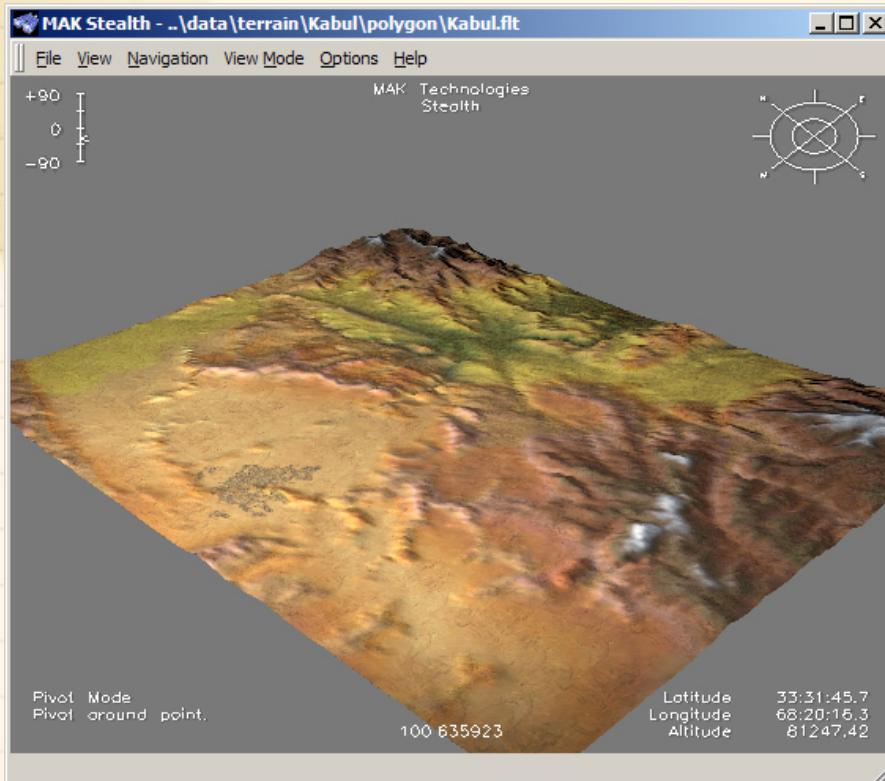


► Symbolic Billboards

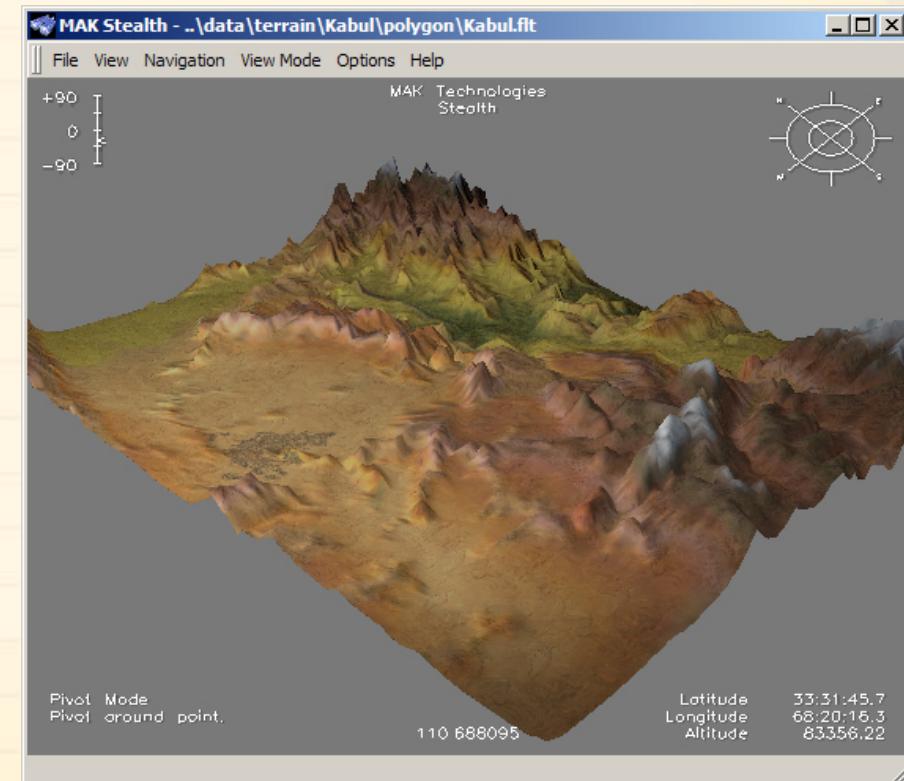
- ▶ - Unit details except orientation
- ▶ + Reduce screen clutter
- ▶ + Best performance



Alternative Terrain Scaling

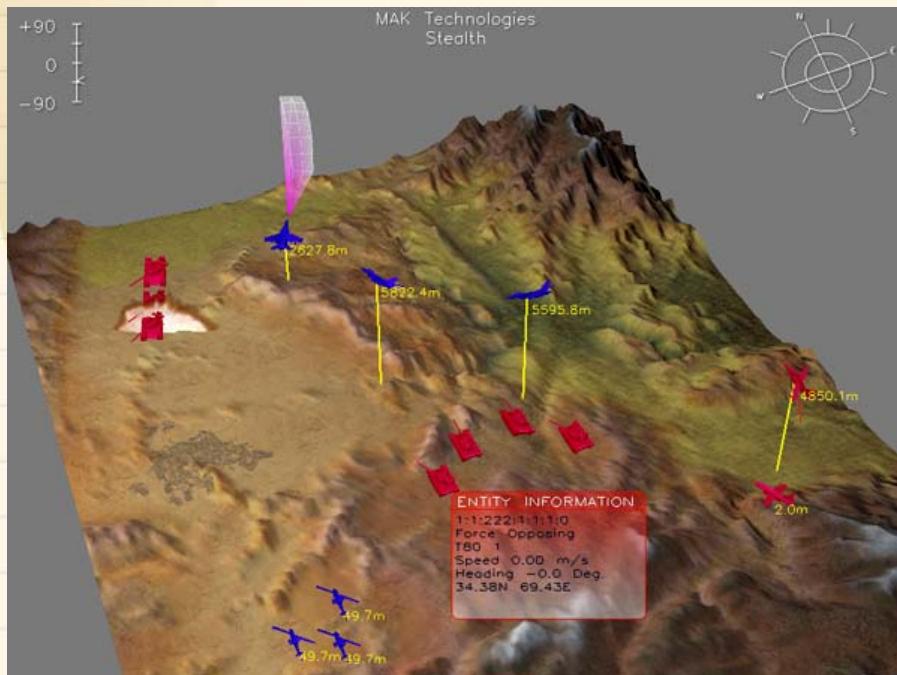


Terrain drawn to scale

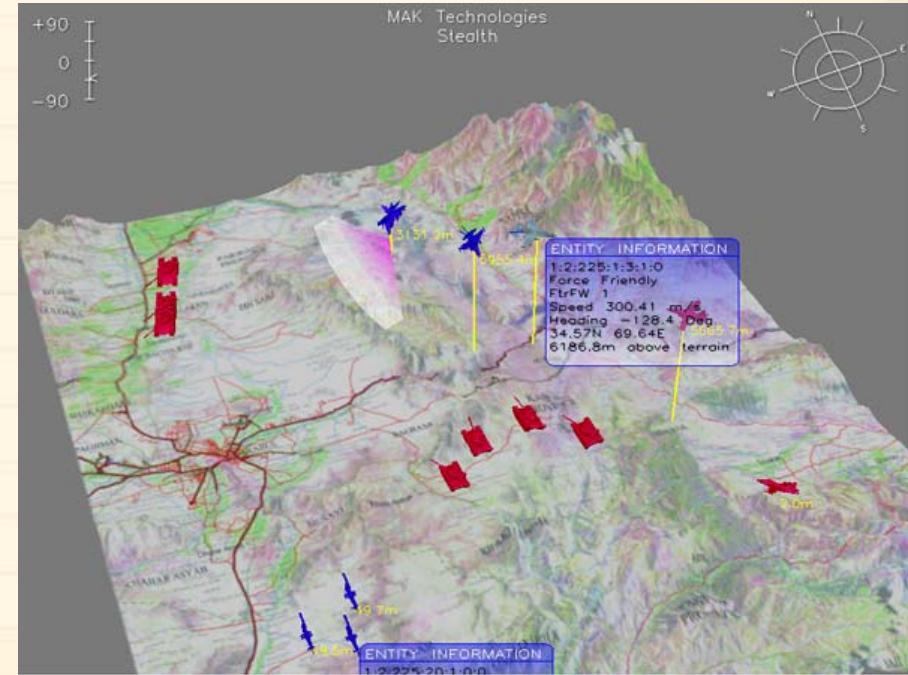


Exaggerated scaling

Alternative Terrain Coloring

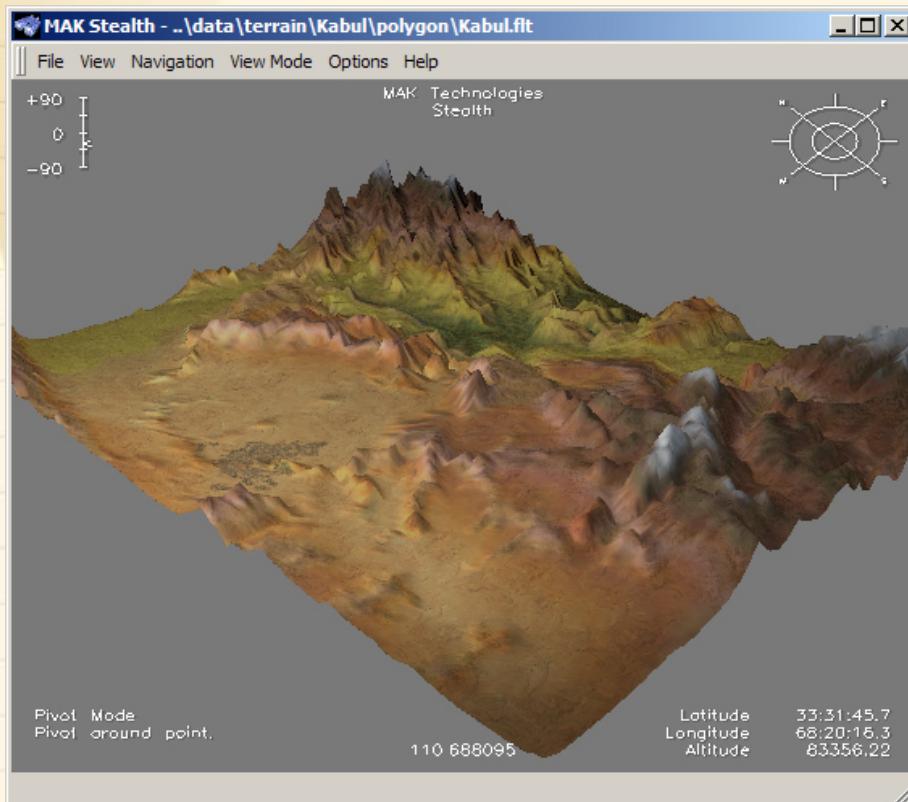


Contour shading

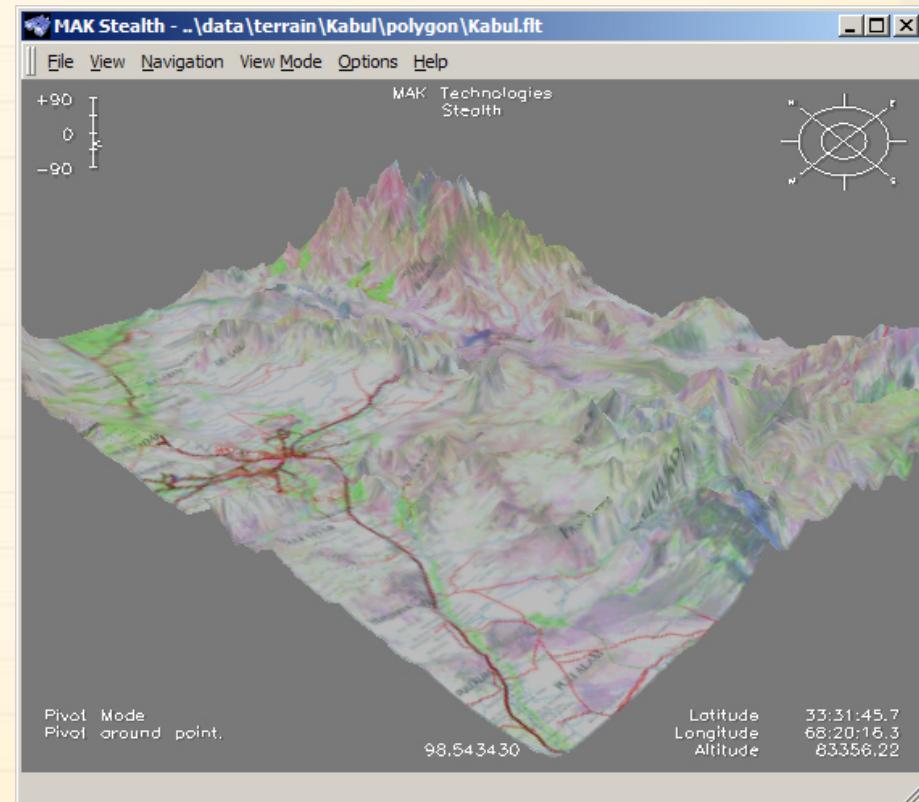


Drape political raster map

Combining Techniques



Exaggerated scaling AND
contour shading

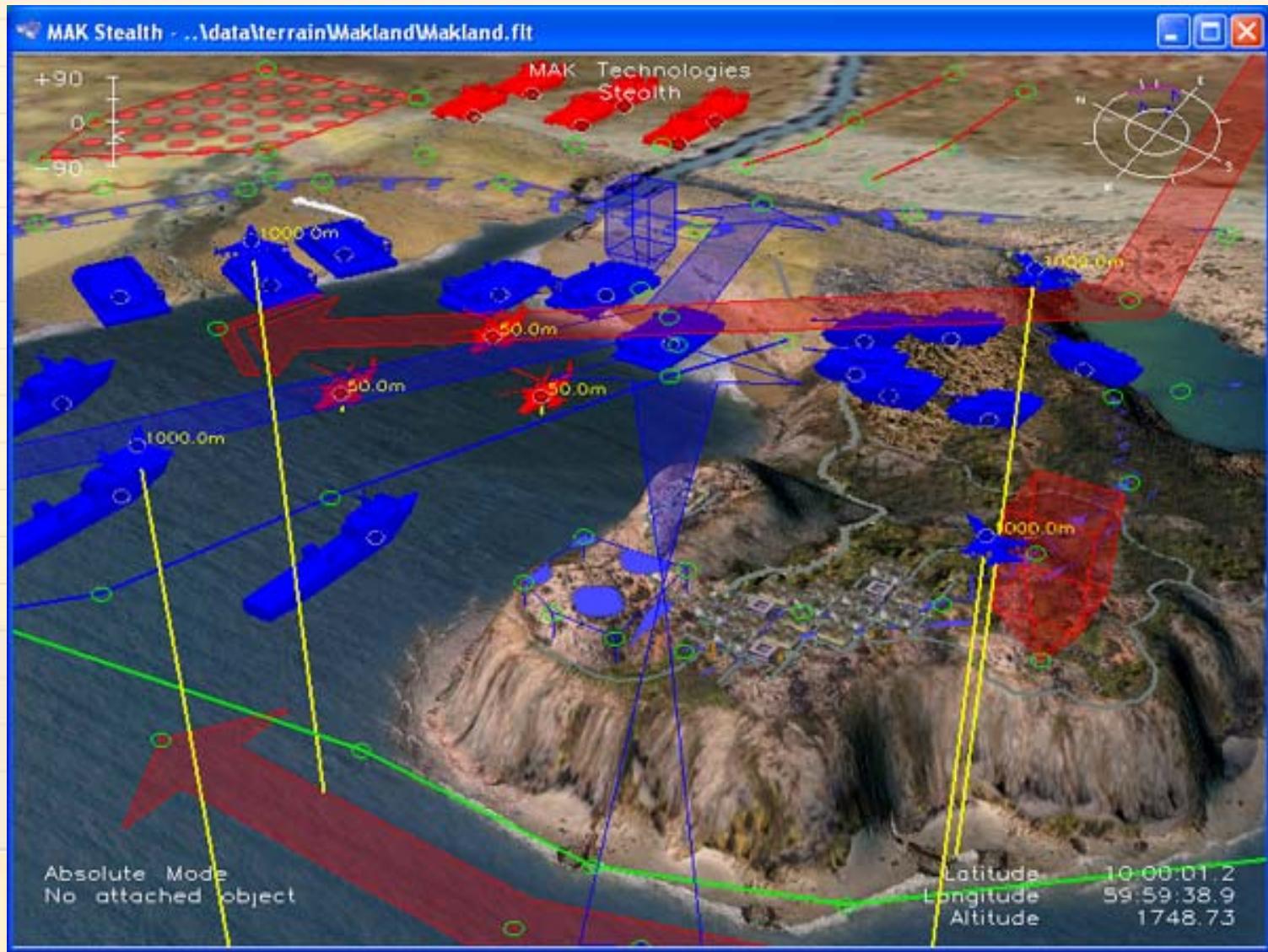


Exaggerated scaling AND
political raster map

Approach: 3 non-realistic techniques

- ▶ Visualization of non-visual data
- ▶ Alternative visualization
- ▶ Data reduction
 - ▶ Eliminate
 - ▶ Compress

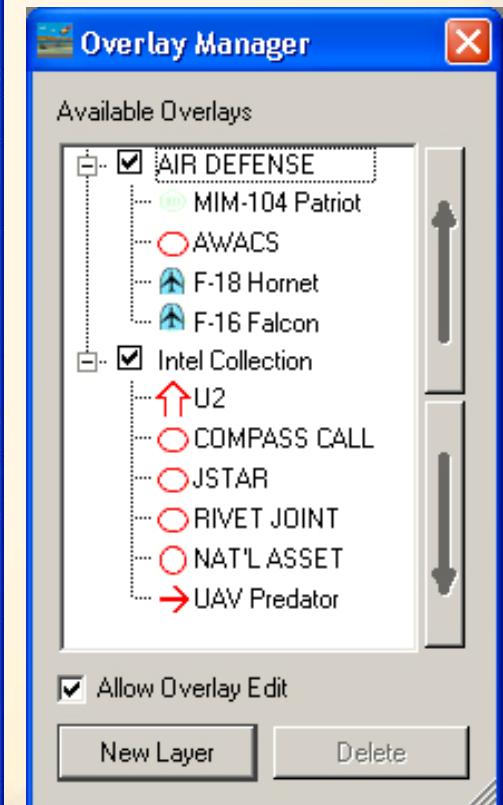
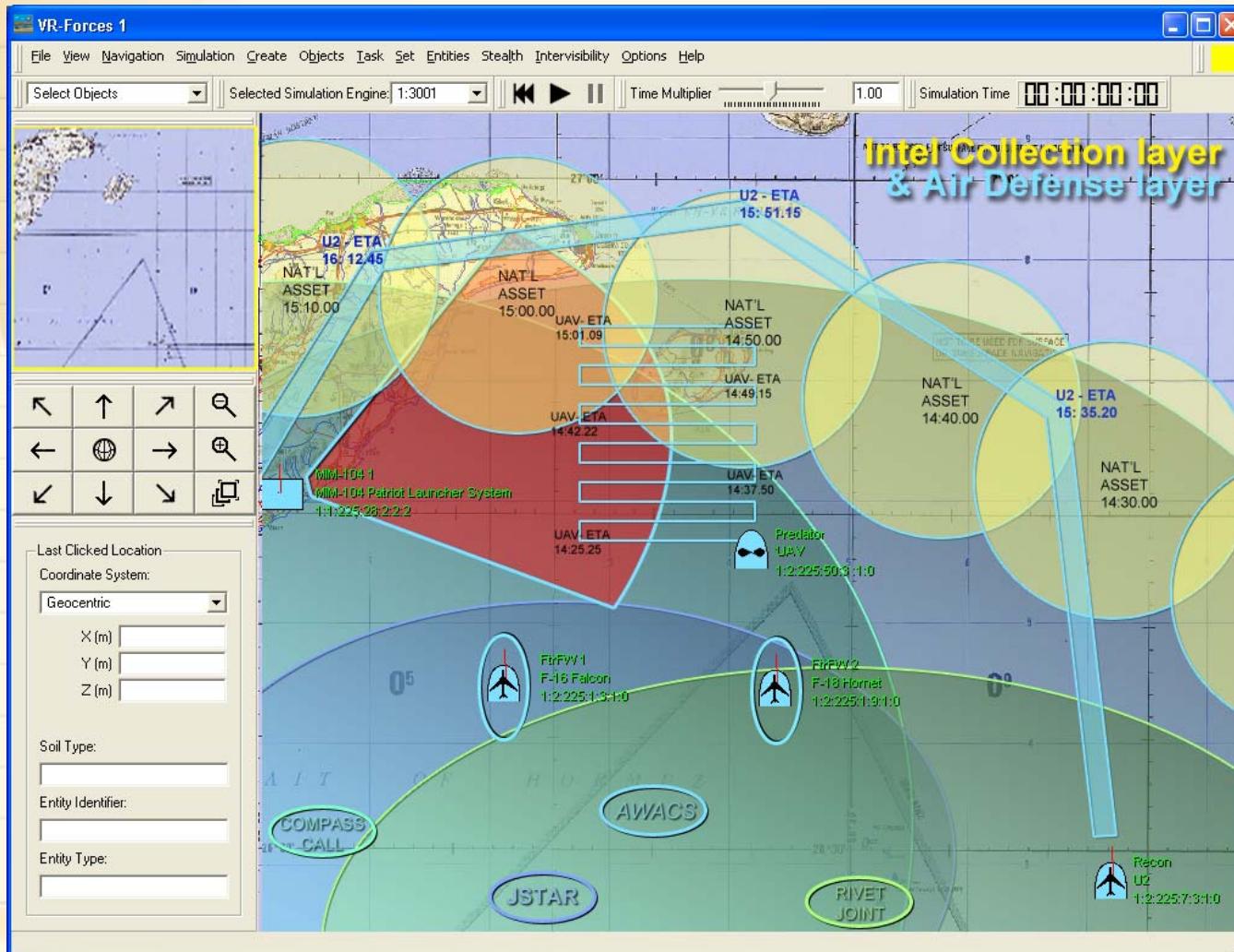
Too much data!



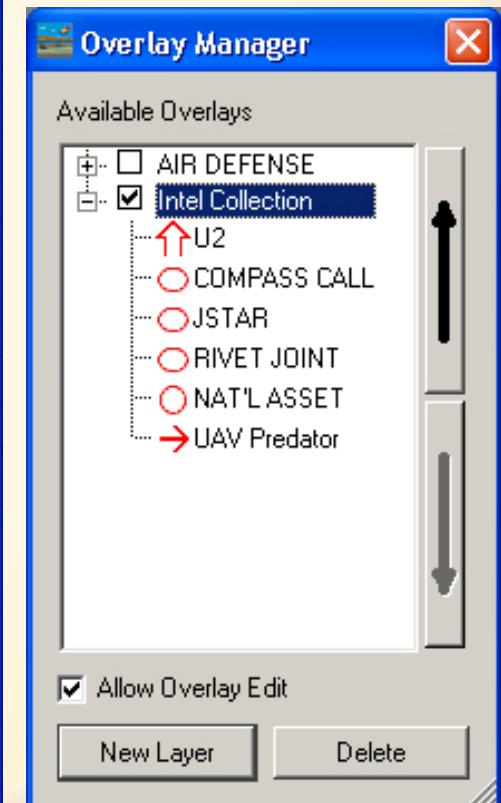
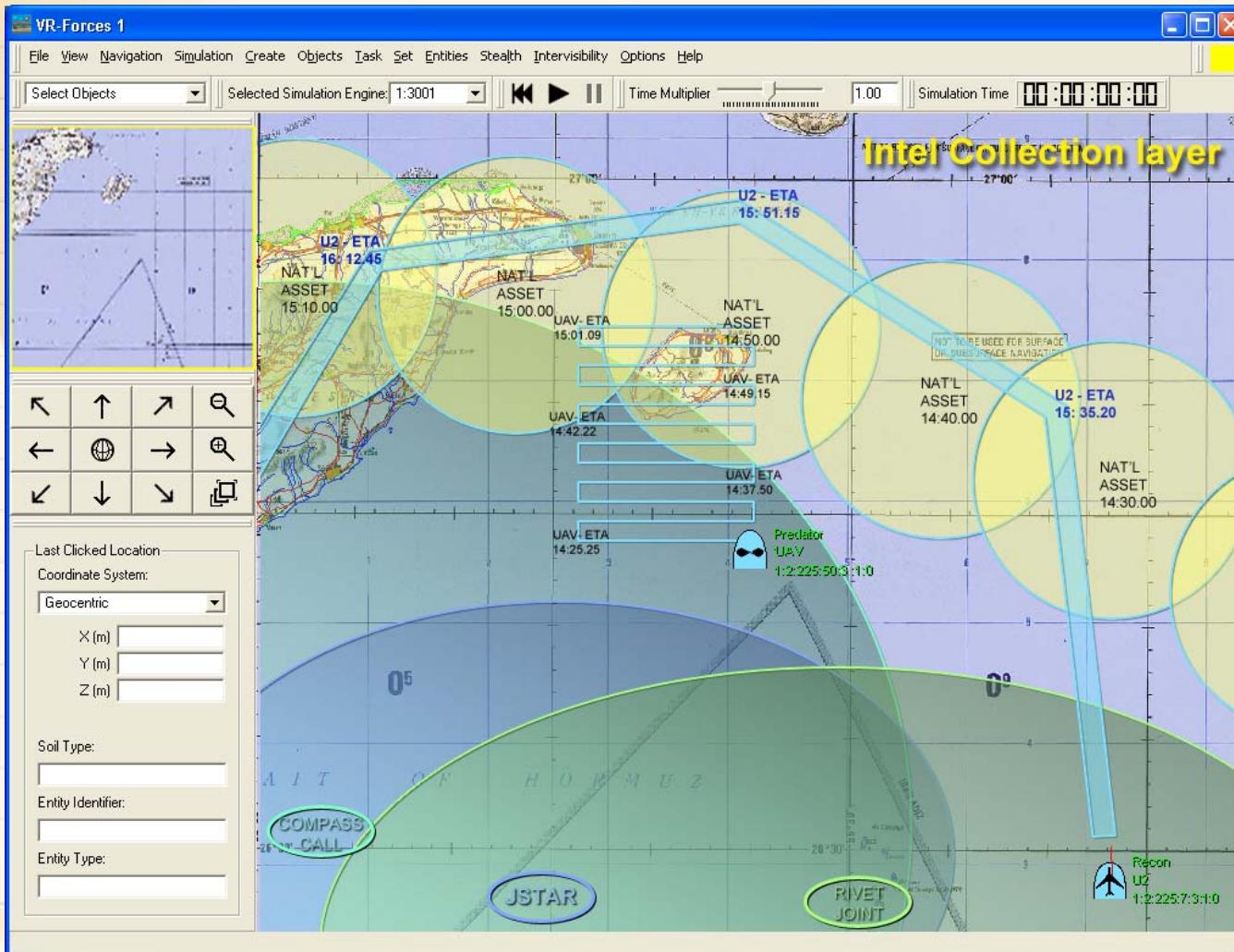
Data Elimination

- ▶ Shared Overlays
 - ▶ Networked sharing of data
 - ▶ Whole screen
 - ▶ Examples: enemy force template, coordination info. (phase lines, fire control lines, maneuver)
- ▶ User Controlled Filters
 - ▶ Not shared
 - ▶ Whole screen or just a subset
 - ▶ Examples: line of sight, hide ineffective air defense units
- ▶ Automatic
 - ▶ Hide unit effects with non-realistic units

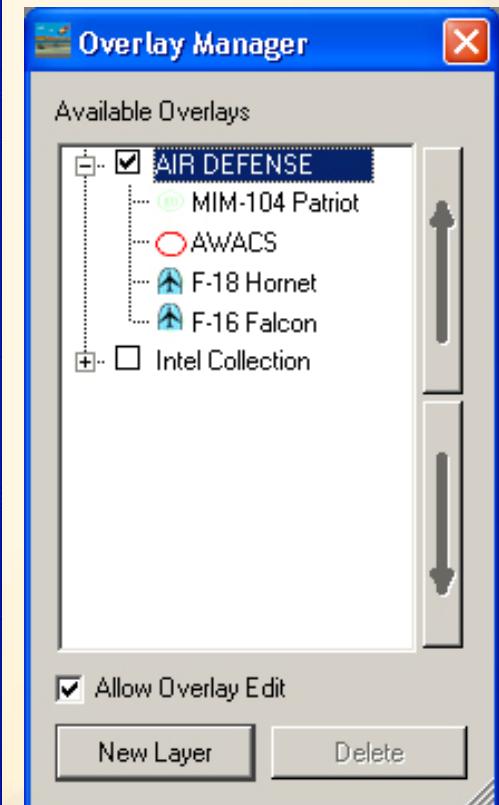
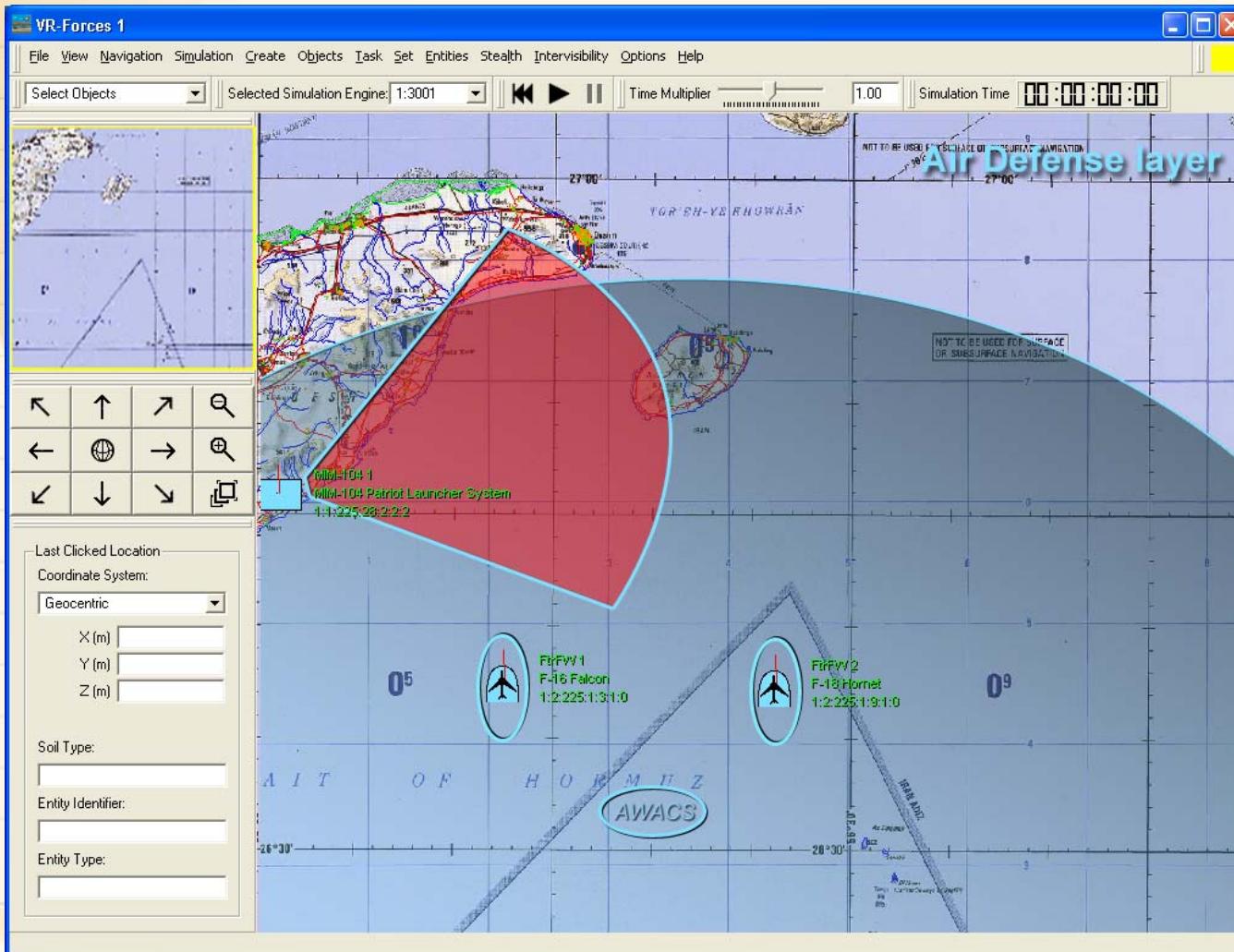
All Overlay Layers – Too Cluttered!



Intel Collection Assets

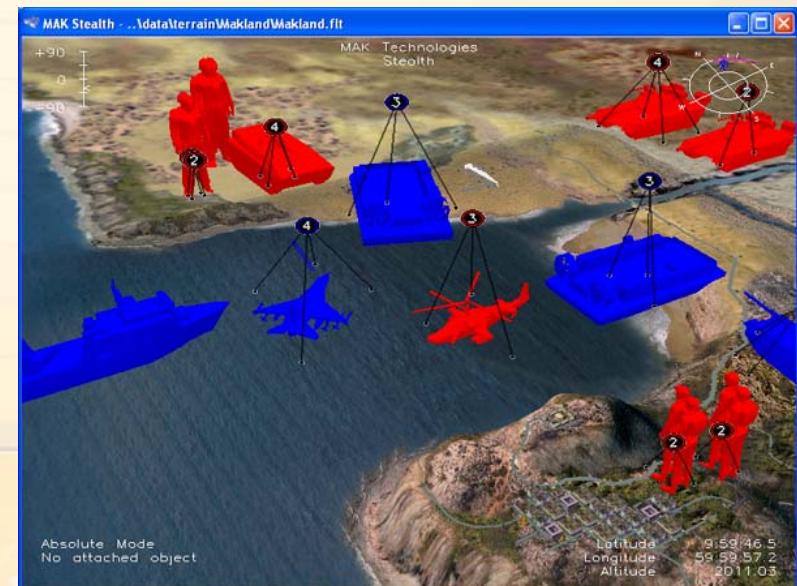
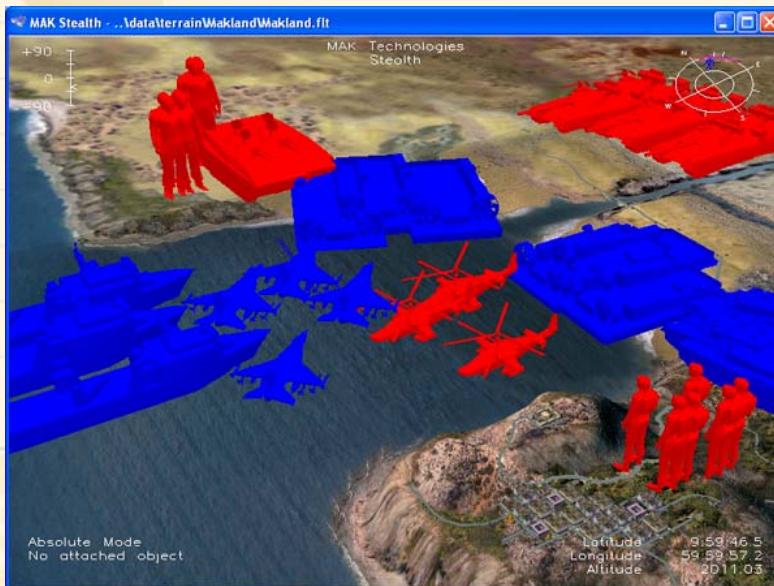
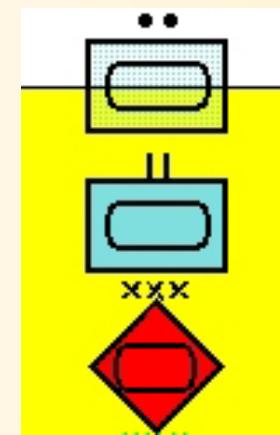


Air Defense Assets



Data Consolidation

- ▶ User controlled dynamic scaling
- ▶ Aggregation (combine units)
 - ▶ Exact same type
 - ▶ Identical platform / domain / force
 - ▶ User defined cluster rules



Technique Interaction

- ▶ Point of view
 - ▶ Saved defaults
 - ▶ Customized views
 - ▶ Cross tool control through other applications
 - ▶ Zoom level to see different levels of detail
- ▶ Other Data Representations
 - ▶ Organizational structures
 - ▶ Unit capabilities (sensors etc.)
- ▶ Reducing Confusion
 - ▶ User customization (Colors / styles for vast number of options)

Results

- ▶ Positive feedback from
 - ▶ Simulation Interoperability Workshop (SIW) 2004
 - ▶ International Training Education Conference (ITEC) 2004
 - ▶ C4I Summit 2004
 - ▶ Transformation and Operations (TOPS) in Cyberspace 2004
- ▶ Used by
 - ▶ OpNet as base toolkit for 3DNV
 - ▶ ITT visualization of hazardous plumes models

Future Work

- ▶ User Studies
- ▶ Better data filtering
- ▶ Knowledge voids
- ▶ Automated data displays
- ▶ Increased performance

Acknowledgements

- ▶ Supported through:
 - ▶ DoD Small Business Innovative Research Program (SBIR) ,
 - ▶ AF02-109 “Multi-sensory display toolkit”
(U.S. Air Force, Rome Labs)
 - ▶ A99-040 “Display Management for Command and Control Applications”
(U.S. Army, CECOM)
 - ▶ Internal product development.

Questions?